

UDOT STRUCTURES DIVISION

DESIGN QUALITY PLAN

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UDOT STRUCTURES DIVISION

DESIGN QUALITY PLAN

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2.0 GENERAL

The UDOT Structures Design Quality Plan has been created to ensure that all structural designs are safe, economical, constructable, maintainable, aesthetic and appropriate for their locations and surroundings. It will be implemented on the designs of all permanent and temporary structures for all projects prepared under the direction of or reviewed by UDOT. This includes but is not limited to the structural design of all bridges, box culvert and other drainage structures, overhead sign structures, retaining walls, sound walls, and structural barriers. It applies to the preparation and checking of all design and construction documents produced by and for the Structures Division and for local government federal-aid projects. This includes but is not limited to reports, design calculations, plans, specifications, special provisions, and estimates.

The Structures Design Quality Plan will be followed regardless of scheduling or deadlines. There are no exceptions. With the approval of the Deputy Bridge Engineer for Design, this plan may be modified on a case-by-case basis to reflect unique aspects of project specific requirements. Submit alternate plans or requested modifications in writing to the Deputy Bridge Engineer for Design for approval. (Use Form SA-1 in the Appendix.)

2.1 RESPONSIBILITIES

The **Deputy Bridge Engineer for Design** is responsible for developing and implementing this Quality Plan.

The **Senior Design Engineer** is responsible for ensuring compliance with this plan. The Senior Design Engineer makes assignments in accordance with this plan and monitors design and detailing activities for compliance with project design and detailing criteria and standards. The Senior Design Engineer assures that the assigned personnel are capable of performing the analysis or calculations required. Project assignments are recorded in the "Design and Detailing Progress" report, which is completed for each set of structure design drawings and becomes part of the design calculations. If the Designer is not a licensed professional civil or structural engineer in the State of Utah, the Senior Design Engineer becomes the Designer of Record for the structure design and stamps the plans and calculations.

The Senior Design Engineer is responsible for releasing the completed contract documents to the UDOT Regions or other entities. Documents should not be released until the Quality Control / Quality Assurance (QC/QA) process is complete. If it becomes necessary to release the documents before the QC/QA process is completed, they must be stamped with "DRAFT," "PRELIMINARY, NOT FOR CONSTRUCTION" or "FOR INFORMATION ONLY," as appropriate.

The **Designer** has the primary responsibility for the completeness, accuracy and adequacy of the design.

The Designer is responsible for inter-discipline coordination. The Designer must not rely upon the checking system to correct deficiencies in the design or calculations. The Designer assembles and maintains the original calculations in an orderly fashion. The Designer presents all calculations in a neat and logical manner which is conducive to checking. If licensed in the State of Utah as a professional civil or structural engineer, the Designer becomes the Engineer in Responsible Charge (EIRC) for the structure design and as such stamps the plans and calculations. The Designer reviews the completed plan set to ensure that it satisfies the design intent. Other designers may assist in the design of certain structural elements, but the Designer who is designated as EIRC has the responsibility to be the lead designer for the assigned structure and shepherd it through the design process.

The **Detailer** has the primary responsibility for accuracy and adequacy of the detailing of the drawing. The Detailer must not rely upon the checking system to correct deficiencies or complete the drawing.

The **Checker** is responsible for checking the drawings or calculations independent of the Designer or Detailer. The Checker can only check work that he/she did not originate.

The drawing Checker is experienced in the structure type being detailed. The drawing Checker will preferably be an engineer, but may be a senior design technician if deemed appropriate by the Senior Design Engineer.

The design Checker is a licensed professional civil or structural engineer in the State of Utah and experienced in the type of structure or element being checked. The Checker is not involved in the original design of the elements being checked.

The Designer and Detailer who complete the original design work are not allowed to participate in the QC or QA check of that work. If more than one Designer or Detailer work on a plan set, they may check work that they did not originate.

The **Engineer in Responsible Charge (EIRC)** is the engineer responsible for the structure design and in that role stamps the plans and calculations. The EIRC will be the Designer if the Designer is licensed as a professional civil or structural engineer in the State of Utah. The EIRC will be the Senior Design Engineer if the Designer is not a licensed Utah PE.

The **QA Engineer** (a senior level engineer) verifies that all applicable documents have been checked in accordance with this policy.

2.2 DESIGN CHECKS AND REVIEWS

Structure designs and drawings are subject to design and detailing reviews in accordance with the following table:

DESIGN REVIEW REQUIREMENTS								
STRUCTURE TYPE	REVIEW TYPE							
	SITUATION & LAYOUT CHECK		60% REVIEW	CADD STDS CHECK	FINAL DESIGN CHECK			FINAL QA REVIEW
	DESIGN	DRWG	DESIGN	DRWG	DESIGN	DRWG	SPECS & EST	ALL DOCS
Bridge	X	X	X	X	X	X	X	X
Drainage Structures	X	X		X	X	X	X	X
Retaining Wall	X	X		X	X	X	X	X
Overhead Signs			X	X	X	X	X	X
Bridge Widening	X	X	X	X	X	X	X	X
Structure Repair			X	X	X	X	X	X
Sound Wall *		X	X	X	X	X	X	X
Structural Barriers *			X	X	X	X	X	X

* Applies only to non-standard sound walls and structural barriers not covered by UDOT standard drawings.

All design reviews except the 60% review include a QA Audit as outlined in this Quality Plan. After the Final Design Check and QA Audit are complete, a senior engineer (usually the Deputy Bridge Engineer for Design or his designee) will conduct a QA Review to ensure that the structure design documents are complete and ready to be advertised.

2.2.1. SITUATION & LAYOUT (S&L) CHECK

The Situation & Layout Sheet(s) define(s) the general concept and geometry of the structure. The Situation & Layout Sheet(s) must be completed, checked, corrected and approved before the Designer begins the final design of the structure. The conceptual design of the structure is checked including the geometric layout, structure type, span length, support locations, girder type and spacing, horizontal and vertical clearances, expansion joints locations, aesthetic requirements, potential utility conflicts, context

sensitivity, preliminary seismic strategy and other items appropriate for the structure being reviewed. The drawings are checked to verify compliance with the *Situation and Layout Detailing Checklist* in the *Structures Division Design and Detailing Standards*. The checklist is completed by the Checker and becomes part of the QC documentation for the structure. The drawings are checked for agreement with the most current roadway drawings. Issues and discrepancies with the roadway information are identified and resolved prior to completing the S&L Check. The S&L drawings must detail any aesthetic and environmental requirements related to the structure as outlined in the appropriate documents.

After the Situation & Layout drawings are checked and issued, the roadway designer will immediately communicate any roadway changes to the bridge designer to prevent unnecessary re-design.

2.2.2. 60% DESIGN REVIEW

At or near 60% completion, structure plan sets are reviewed to verify concept and scope. This is not a detailed design or drawing check, but a review to validate the design direction and ensure that the design scope and intent and all project design criteria and requirements are being met. This review provides an opportunity to make changes in the design before it progresses to the point where design changes become prohibitive.

2.2.3. CADD STANDARDS CHECK

All drawings will be checked to verify compliance with correct drafting practices and CADD Standards. The CADD Standards Check occurs prior to the drawing QC check. If the drawing does not meet CADD Standards, it will be corrected before proceeding with the drawing QC check. The CADD Standards Check will be completed by a Senior Design Technician.

2.2.4. FINAL DESIGN CHECK

During the Final Design Review, all drawings are thoroughly checked as a complete package. Although previously checked, the latest S&L is once again checked during the Final Design Review to ensure compliance with the latest roadway plans and to verify that information and details not available at the S&L phase are included.

The entire set of design documents (plans, calculations, specifications, engineer's estimate, etc.) will be checked. All checking will be completed before the PS&E package is submitted. Changes to the design package after the QC process is complete will be checked by the same procedures.

2.2.5. UDOT OVERSIGHT REVIEWS

All consultant-designed structure projects are subject to oversight reviews by a UDOT Structural Engineer. UDOT oversight reviews occur at the following design stages:

1. Situation & Layout (in conjunction with the S&L Design Approval),
2. 60% Design Review, and

3. Review of Final Design (may occur in conjunction with the PS&E Review).

The UDOT Structures Oversight Engineer assigned to the project may request additional oversight reviews if deemed necessary.

2.2.6. FINAL DESIGN QA REVIEW

The Final Design QA Review is completed by the UDOT Deputy Bridge Engineer for Design or his designee whether it is a UDOT internal project or a consultant-designed project. The Final QA Review takes place after the PS&E Review and just prior to the Final Design Approval. The submittal includes all design documents as indicated on the Final Design QA Review Checklist.

2.3. DESIGN APPROVALS

Design approvals are required at specific design milestones. Submit structure designs to the Deputy Bridge Engineer for Design for approval at the following milestones:

DESIGN APPROVAL REQUIREMENTS		
STRUCTURE TYPE	APPROVAL TYPE	
	SITUATION & LAYOUT	FINAL DESIGN
Bridge	X	X
Drainage Structures	X	X
Retaining Wall	X	X
Overhead Sign Structure		X
Bridge Widening	X	X
Structure Repair		X
Sound Wall*		X
Structural Barrier*		X

* Applies only to non-standard sound walls and structural barriers not covered by UDOT standard drawings

2.3.1 SITUATION & LAYOUT APPROVAL.

Approval of the Situation & Layout sheets is required prior to proceeding with the final design. Submit the following:

1. Situation & Layout plan sheet(s)
2. Design Plan QC Certification
3. Bridge Type Selection Report
4. Preliminary Seismic Strategy Report
5. Design Criteria Summary
6. Design Exceptions Approvals (if applicable)
7. Computer Software List

2.3.2 FINAL DESIGN APPROVAL.

Approval of the final design is required prior to releasing the plans for construction. Submit the following:

1. Completed structure plan set (signed and sealed)
2. Specifications (Special Provisions)
3. Engineer's estimate
4. Design Certification Forms (Complete for Final Design)
5. Design Criteria Summary
6. Approved Design Exceptions
7. Computer Design Software List
8. Final Seismic Strategy Report
9. Geotechnical Report
10. Bridge Load Rating Report
11. Previous review comments with responses and final dispositions
12. Design Calculations (required for all UDOT designs; when requested for local agency bridges)
13. Independent Review Checklist, Letter Report and Calculations (when required)
14. Any other final design documents and reports, as appropriate

2.4 DESIGN REPORTS

2.4.1 BRIDGE TYPE SELECTION REPORT

A Bridge Type Selection Report will be prepared by the Designer and submitted to the UDOT Deputy Bridge Engineer for Design prior to completing the Situation & Layout Sheet. The Bridge Type Selection Report is a one-to-three page report that outlines the bridge types considered and includes the following:

1. Preliminary costs of the bridge types evaluated (minimum of two bridge types)
2. Advantages and disadvantages of the bridge types evaluated
3. Bridge type recommendation

2.4.2 SEISMIC STRATEGY REPORT

The design of each bridge requires the preparation of a Seismic Strategy Report. A preliminary report will be included with the Situation and Layout approval submittal. An updated report will be submitted with the Design Midpoint Review submittal. The Final Seismic Strategy Report will be submitted with the Final Design Review submittal.

The Seismic Strategy Report describes the design strategy for resisting the design seismic event. Include descriptions of expected damage, the locations of plastic hinging, the redistribution of forces, the mobilization of backfills, and the function of bearings, as appropriate.

2.4.3 BRIDGE LOAD RATING REPORT

FHWA requires that all bridges be load rated. The designer is responsible to load rate all bridges using methods described in the *AASHTO Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges*. The final inventory load rating shall meet or exceed HL-93. Provide both inventory and operating ratings.

The Load Rating Report is submitted with the Final Design Submittal. It provides a summary of the bridge load rating of the completed design and the supporting calculations. Include both operating and inventory ratings in the load rating summary. The supporting calculations for the Bridge Load Rating Report are formatted the same as the Bridge Design Calculations.

2.5 QUALITY PROCEDURES

2.5.1 PREPARING STRUCTURE DESIGN CALCULATIONS

Design Activity: 49D, 01P, 05P, 07P, 10P

Introduction

All calculations are recorded on standard UDOT Structures Division letter-sized calculation sheets. All information is printed, title boxes filled in completely, initials used in the sign-off blocks, pages numbered, sketches used as necessary to clarify the design, and all assumptions, references, units and conclusions are clearly stated. The originals and check prints of all hand calculations are indexed and stored in three-ring binders. All calculations are to be neat, complete, concise, organized and accurate.

The **Senior Design Engineer** assures that the personnel assigned to the project are capable of performing the analysis or calculations required. Assigns the Designer to maintain and organize the original calculations for the structure in an orderly fashion and in accordance with this policy.

The **Designer** is responsible to create and maintain the design calculations for the assigned structure in a neat and logical manner which is conducive to checking and in accordance with this policy.

The compiled design calculations will include the following:

1. Title page with Structure Drawing Number, Structure Name, Design Calculations title, Designers name, PE Stamp (signed and dated).
2. Table of Contents
3. Completed Design Certification Forms. (The PE Stamp on the Certification for Design Calculations can replace the PE Stamp on the title page.)
4. Completed Design Approval Forms
5. Completed Alternate Design Quality Plan Approval for any project-specific modifications to the Structures Design Quality Plan
6. Design Criteria Summary (include a list of applicable AASHTO design specifications used in the design)
7. Design Criteria Exceptions (a list of any deviations from the project design criteria along with the approval documentation)
8. List of computer programs and spreadsheets used in the design
9. Completed Design & Detailing Progress Form
10. Where possible, use standard Structures Division letter-sized calculation sheets for handwritten calculations and sketches.
11. Use standard letter-sized paper for computer generated calculations with UDOT Structures standard heading.
12. Number all pages with a numbering scheme that covers the entire set of calculations.
13. Identify the appropriate code references in the right hand column of the calculations.
14. Reference computer programs and indicate appropriate code section.
15. Computer documentation includes: name of program, vendor, version and release date.
16. Bridge Type Selection Report
17. Seismic Strategy Report
18. Bridge Load Rating Report and Calculations

The Deputy Bridge Engineer for Design approves all computer design software (including spreadsheets) before it may be used in the design. A list of approved design software will be maintained by the Deputy Bridge Engineer for Design. Computer design software and spreadsheets that are not on the approved list must be verified in accordance with the procedures for Computer Software Verification in this Quality Plan before they may be used in the design.

When Independent Review and/or Load Rating Calculations are required, organize and format them the same as the original structure design calculations.

When the design is complete, the Designer fills out the Design Certification Section of the Design Certification for Design Calculations.

2.5.2 CHECKING STRUCTURE DESIGN CALCULATIONS

Design Activity: 49D, 01P, 05P, 07P, 10P

General

The structural analysis and design of all structures will be checked to verify that the design complies with the project design criteria and proper engineering design methodology and practices. A proper design check confirms the structural adequacy of the overall structure and individual components by eliminating mathematical errors and misunderstandings of the design criteria that may produce an unsafe design or cause significant cost increases due to plan errors. The design check verifies (1) the design theory and correct interpretation of the design criteria, and (2) the accuracy and completeness of the design calculations to confirm the structural adequacy of all bridge elements.

All calculations, including computer input, shall be checked using a Red-Yellow-Green (RYG) check as described in this section and "Checking Input to Computer Programs." The design check is completed before the plans are checked and preferably before the plans are detailed.

The Senior Design Engineer may also require an independent review on any or all parts of the design. Reasons for an independent review may include, but not be limited to, a complex or unusual structure, an inexperienced designer, or inexperience with the type of structure being designed. An independent review requires a separate set of calculations. The independent review is initiated after the bridge has been designed and QC checked, and the drawings are sufficiently complete to depict all design information and structural details.

The Senior Design Engineer, in the role of supervising engineer, will be involved in the design and will review the design and detailing as necessary to ensure completeness and accuracy of the design.

Responsibilities

The **Designer** prepares a copy of the design calculations and gives it to the Checker for checking.

The **Checker** checks all aspects of the calculations including the following: format, assumptions, AASHTO references, computer input references, calculations, and that the design complies with the applicable design criteria and seismic strategy. The Checker will check the design for completeness, accuracy, economy, and that it is not excessively conservative.

The **Independent Reviewer** is a senior engineer currently licensed as a professional civil or structural engineer in the State of Utah, and having a minimum of five (5) years experience designing bridge structures of the same type receiving the independent review. The independent reviewer will generate a separate set of calculations independent of the original calculations. The Independent Reviewer will not have been personally involved in the engineering calculations or design of the bridge structure.

PROCEDURE

Red-Yellow-Green (RYG) Check

The RYG calculation check consists of the following:

1. When a calculation or series of calculations have been completed, the Designer (Originator) makes a photocopy of the original and provides it to the Checker for checking.
2. The Checker marks up the calculations in **yellow** (if checked as correct) and **red** (if corrections are required) and signs the Check Print copy of the calculation sheet in the "Checked by" block.
3. The Designer (Originator) back checks the checker's marks on the Check Print. If in agreement, the Designer changes the original set of calculations to reflect the Checker's comments. To document the back checking process, the Designer:
 - a. Check-marks in **green** each of the checker's red-marked changes if in agreement and adds in **green**, with the concurrence of the Checker, any additional changes not picked up by the Checker.
 - b. Crosses out in **green** each of the Checker's red-marked changes that both the Designer and the Checker agree should not be changed and writes "OK" next to the crossed-out change. The Back Checker should not obliterate the checker's marks.

NOTE: The Back Checker (originator) and Checker should resolve differences encountered during the checking process so they are not repeated over and over again. If resolution cannot be achieved by the two individuals, the appropriate Senior Engineer should be requested to resolve the differences.

4. The Checker, acting as the verifier, examines the original calculation sheets to see that the agreed-to corrections have been made, marks all red corrections with bold yellow to show correct, and signs and dates the "Checked by" block in the original calculations.
5. The original calculations and Check Prints are indexed and placed in the project files.
6. The Designer of Record seals, signs and dates the Design QC Certification section of the Design Certification for Design Calculations form.

Independent Review Procedures

When directed by the Senior Design Engineer, a senior level designer will complete an independent review of the structure. One major advantage of the independent review is the assurance that a senior engineer experienced in bridge engineering design has independently reviewed the bridge design in specific detail and has attested to its adequacy.

The independent reviewer shall not have been personally involved in the engineering calculations or

design of the bridge structure. He/she shall personally make independent calculations on specific bridge elements, except that computer analysis and seismic computer calculations may be assigned to another person who is under the responsible charge of the independent reviewer if the independent reviewer accepts responsible charge for their accuracy.

The independent review calculations shall not reference the original design calculations. The structural elements that require independent calculations are those bridge elements, which if they were to fail structurally, would cause a threat to life-safety (i.e., the bridge deck, girders, bent caps, columns, pile caps, seat abutments, and piles.) In addition, beam seat width dimensions shall be calculated for seismic adequacy.

The independent review documentation consists of a completed independent review checklist, independent calculations, and a letter report. The letter report from the independent reviewer shall bear his/her PE stamp and signature and shall attest that:

1. The independent review was performed independently,
2. Any structural deficiencies found have been corrected to the satisfaction of the independent review engineer, and
3. The specific areas or elements of the bridge which were deemed to be critical stress areas are adequate.

The independent review documentation becomes part of the QC Documentation for the structure.

2.5.3 CHECKING INPUT TO COMPUTER PROGRAMS

Design Activity: 49D, 01P, 05P, 07P, 10P

General

Use this procedure for checking both non-local (batch) input and local keyed input to PC's.

Procedure

1. When any computer program is run for design, the input and output must be printed out at the same time.
2. The input for the PC or CADD shall be **yellow-line** checked (COGO runs will also have a plot run as a check) and signed by off the Checker. Corrections will be noted in **red**.
3. The input for non-local input shall be documented, copied, and **yellow-line** checked on the appropriate forms prior to forwarding for batch processing. After processing and running the program, the printout of the input shall be verified (compared to the original Check Print) using a **green** pencil to indicate each item is correct.
4. The Originator will back check the corrections and either rerun the program or calculate and pen in the correct values in the output, as appropriate. The Checker verifies the corrections and initials the corrections.
5. If the program is rerun, a new, complete, **yellow-line** checking of the input must be completed.
6. Keep all computer input check prints with the QC documentation in a loose leaf binder with the other project calculations.

2.5.4 PREPARING STRUCTURE DRAWINGS

Design Activity: 49D, 01P, 05P, 07P, 10P

The **Designer** has the primary responsibility for ensuring that the structure plan set is complete and accurate and reflects the intent of the design. The Designer should not rely on the checking process to find and correct errors and omissions.

The **Detailer** has the primary responsibility for preparing structure drawings that comply with UDOT Structures Detailing and CADD standards. This includes compliance with requirements of drawing format and appropriate detailing practices and requirements. Under the direction of the Design Engineer, the Detailer prepares drawings that reflect the design as identified in design sketches and details included in the Structure Design Calculations. Drawing preparation includes quantity calculations. The Detailer should not rely on the checking process to find and correct mistakes.

Compliance with detailing standards and requirements provides detailing consistency between structure plan sets. Consistency in detailing increases drawing quality and presentation. Consistency of the electronic CADD file also makes the drawing easier to modify or correct. Format and detailing consistency between structure plans sets also provides plans that are easier to interpret for contractors and construction field crews.

UDOT STRUCTURE NUMBERS

Obtain from the UDOT Structures Division a UDOT structure drawing number for each permanent bridge, retaining wall, overhead sign structure, and major drainage structure such as a box culvert or headwall. This is done through the UDOT Structures web-site (<http://www2.udot.utah.gov/index.php/m=c/tid=277>). Modifications to existing structures also require a new UDOT structure drawing number. The UDOT structure drawing number is shown in the title block on each sheet of the plan set and is the primary reference for identifying the structure.

PLAN ORGANIZATION AND CONTENT

Under the direction of the Designer, the Detailer prepares complete and accurate structure design plans that comply with the following:

1. Provide structure design plans that include all design details necessary to construct the structure. This includes but is not limited to conduit, inserts and attachments, the location of lighting fixtures attached to the structure, and approach slab and deck drains. For structures where detailed design details are developed and provided by a supplier (such as MSE retaining walls and structural plate arches), the supplier's design details will not be available until the construction phase. These should be added to the final structure plan set for inventory purposes when they are available.
2. Create all drawings in the current Microstation format in accordance with UDOT CADD Standards as defined in the *UDOT Engineering Technology Systems Manual*.

3. Use the standard UDOT Structures Division border and title block on all plan sheets. On design-build projects, replace the State Bridge Engineer signature with the signature of the Design-Builder's Structure Design Manager. Supplier-detailed drawings that are included in the final plan set may use the supplier's border and title block
4. Provide Situation and Layout plan sheets for all bridges, box culverts and rigid frame drainage structures, retaining walls, and non-standard sound walls and barriers. Provide Situation and Layout plan sheets that meet the requirements in the "Situation and Layout Sheet Requirement Check List" included in the *UDOT Structures Division Design and Detailing Standards*.
5. When corridor standard plans are used on design-build projects to replace details typically included in the structure plan set, include the applicable corridor standard plan sheets with each structure plan set and list them in the Index of Sheets on the Situation and Layout Sheet.
6. Include in the bridge plan set a soil boring location plan and the soil boring and CPT logs used in the geotechnical design of the bridge foundations.
7. Organize the plan sheets in the bridge plan set in the general order of construction.
8. A complete retaining wall plan set consists of (1) a location plan showing the location of all retaining walls pertaining to the structure number, (2) the situation and layout plans for each individual retaining wall showing the wall geometry and applicable general design details, and (3) detailed drawings for each individual retaining wall that include all structural details necessary to construct the wall. For proprietary wall systems, the detailed drawings are prepared by the wall supplier and will not be available until the construction phase. They should be added to the final structure plan set for inventory purposes when they are available.
9. All design plans require the seal and signature of a Utah PE.

See the *UDOT Engineering Technology Systems Manual* for more information on UDOT CADD Standards, CADD file naming conventions, file management, proper referencing of appropriate files, and detailing standards.

2.5.5 60% DESIGN REVIEW

Design Activity: 49D, 01P, 05P, 07P, 10P

When the structure drawings have progressed to the point where the design of major structure elements are adequately illustrated (at or near 60% completion), the Senior Design Engineer will conduct a 60% Design Review. The purpose of this review is to identify any design flaws that will significantly affect the design before the design and detailing progress to the point where it becomes prohibitive to modify the design. The 60% Design Review is not a detailed check of the design or the drawings, but a check of the general concept and functionality of the structure. This review occurs prior to the final drawing check. Scheduling the 60% Design Review as early in the design process as possible will improve the opportunity to incorporate quality, efficiency, and economics into the design without significant redesign. This review may also identify structural elements that require special design procedures. For unusual or complicated structures, the Senior Design Engineer may organize a review team to participate in this review. The review team may include representatives from the bridge inspection group, construction, maintenance, and other design disciplines.

The 60% Design Review submittal will typically include the following unchecked drawings:

60% REVIEW PLAN SUBMITTAL CONTENT		
BRIDGE	OVERHEAD SIGN STRUCTURE	OTHER STRUCTURE TYPES
Situation & Layout Soil Data Sheets Pile Details Foundation Plan Abutment Details Bent Details Framing Plan Girder Details Camber Diagrams Diaphragms / Cross-frames Bearings Post-Tensioning and/or Prestressing Details Deck Details Screed Elevations Parapet Details Other Major Element Details	Sign Location Sign Panel Geometry Sign Support Geometry Roadway Typical Sections Foundations	All Details (unchecked)

The Reviewer will check the design for constructability, maintainability, inspectability, and that the standard details are correctly applied. The Reviewer will verify that the design matches the project criteria and scope, and that all aesthetic and environmental requirements are being incorporated into the structure. The final seismic strategy report will also be reviewed.

The 60% Design Review includes the following elements:

1. **Seismic Strategy.** Verify that the seismic strategy is appropriate for the structure situation and characteristics. Verify that the seismic strategy is applied correctly in the structure plans.
2. **Standard Details.** Verify that standard details are used appropriately. Ensure that any non-standard details are appropriate.
3. **Constructability.** Check the plans for problems that would impact construction. Identify details that would require the Contractor to do the impossible or near impossible. Identify details or construction sequencing that can be modified to improve constructibility without impacting the quality or design life of the completed structure.
4. **Inspectability.** Verify that all major components of the completed structure are accessible for inspection.
5. **Maintainability.** Check the major elements of the bridge for built-in problems that would impact bridge maintenance. For instance, verify that the deck drains will not soak the girders or substructure. Identify erosion or snow removal problems that can be avoided.
6. **Compatibility** with the surrounding environment and adjacent project elements. Compliance with project aesthetics and environmental requirements, etc.
7. **Significant Design Flaws.** Identify any design flaws that will significantly affect the design and construction.

Each Reviewer fills out and signs the “60% Design Review Checklist” and gives it to the Designer who places a copy with the QC documentation and a copy in the design calculations.

2.5.6 CADD STANDARDS DRAWING CHECK

Design Activity: 01P, 05P, 07P, 10P

The Originator of the work has the primary responsibility for compliance with UDOT Structures CADD Standards. The Originator should not rely upon the checking process to find and correct his/her mistakes.

All completed drawings will be checked to verify compliance with correct drafting practices and UDOT CADD Standards. This will provide consistency of structures plan drawings and ensure that proper CADD procedures are followed. It also identifies CADD training needs. The CADD Standards Check occurs prior to the drawing QC check. If the drawing does not meet CADD Standards, it will be corrected before proceeding with the drawing QC check.

The CADD Standards Drawing Check is completed by a Senior Design Technician, as assigned by the Senior Design Engineer, to check MicroStation data for compliance to Standards and Procedures. This check is performed on all files that will be released for construction.

The CADD Standards Check will check for the following:

1. All CADD contract drawings are produced in the current MicroStation format according to UDOT CADD Standards (see *UDOT Engineering Technology Systems Manual*).
2. Proper file naming conventions are followed. File names reflect the nature of their contents.
3. Correct line styles are used and are on the correct levels. Correct text size and type are used.
4. All details are drawn to scale.
5. Reference files (stored as read only) are used, as opposed to the copying of existing data (as appropriate).
6. Correct seed files or libraries of standard features/details (stored as read only) are used. No changes to an existing approved standard may be made without the approval of the Senior Design Engineer.
7. All CADD-produced prints will automatically produce the date, time and filename printed outside the left border.
8. When the CADD Standards Check is complete, fill out and sign the CADD Standards Drawing Review Checklist. The checklist will be kept with the QC documentation for the structure. Also, place a copy in the Design Calculations.

2.5.7 CHECKING STRUCTURE DRAWINGS

Design Activity: 49D, 01P, 05P, 07P, 10P

The checking of structure drawings requires a minimum of two individuals: a checker / verifier, and an originator / back checker. In most cases, the Originators of the drawing are the Designer and the Detailer. The Checker/Verifier is a designer not involved in the original design. Do not begin the final drawing check until the design calculations are complete and checked and the CADD Standards Check is complete.

1. Completing the Drawing

A drawing is considered complete and ready for checking when the Originator certifies that the content is complete and accurate and that the detailing and CADD work follow all applicable standards. The Originator is responsible for the completeness and accuracy of the drawing, and should not rely on the checking process to correct errors in content and format.

As each drawing is completed in final format and deemed ready for checking, the Originator initials the title block of the drawing, makes a Check Print copy, and affixes, numbers and dates the Check Print stamp (see Appendix) on the print of each drawing. When all drawings for the structure are complete and stamped, the Designer gives them as a complete package to the Checker.

2. Checking

The Checker checks the Check Prints of the drawings for completeness, consistency throughout the plan set, technical adequacy and conformance to any applicable standards and format, and performs specific accuracy checks required for that type of drawing. In cases where individual drawings are checked (not as a complete plan set), the Checker must check the completed plan set for completeness and consistency between drawings before the checking is considered to be complete.

The Checker checks each drawing to ensure that it accurately represents the design as described in the corresponding design calculations, and verifies that those calculations have been properly checked. This includes the checking of quantities. The Checker should not proceed with the drawing check unless the calculations have been checked. The Checker documents the checking process by highlighting in **yellow** on the Check Print each part checked that is found to be correct, and marking in **red** on the Check Print any required corrections, additions, or deletions.

NOTE: Red or yellow should not be used to note comments or instructions. These colors are reserved for the checking process. Write comments or instructions in blue.

The Checker will check all details on the drawing for adequacy, completeness, correctness, clarity, appropriate proportions, and proper dimensioning. All text and notes will be checked for correctness and applicability. The quantity subtotals and totals will be checked. The completed check print will show that all drawing elements (details, text, notes, etc.) without exception have been checked by being marked either in yellow or red. The Checker will also compare the details and information on each sheet with the same or similar information on other sheets to ensure that

there are no conflicts and that all elements fit together properly.

When the checking is complete, the Checker signs and dates the Check Print stamp and returns it to the Originator.

***NOTE:** In the case where no corrections, additions or deletions are found, there is no need for back checking or further signatures on the Check Print stamp. The Check Print and original drawing, signed in the appropriate checked block, is returned to the Originator for placement in the project file.*

3. Back checking

The Originator (acting as Back checker) reviews the Checker's marks on the Check Print and personally makes or supervises the update of the Drawing Original. To document the back checking process, the Originator:

- a. Check-marks in **green** each of the Checker's red-marked changes if in agreement that the Original should be changed, and adds in **green**, with the concurrence of the Checker, any additional changes not picked up by the Checker.
- b. Crosses out and marks OK in **green** each of the Checker's red-marked changes that both the Originator and the Checker agree should not be changed. The Backchecker should not obliterate the Checker's marks.

***NOTE:** The Back checker and Checker should resolve differences encountered during the checking process so they are not repeated over and over again. If resolution cannot be achieved by the two individuals, the Senior Design Engineer should be requested to resolve the differences.*

- c. Signs and dates the Check Print stamp.

4. Correcting the Drawing Original

The Drawing Original is corrected by the Detailer under the supervision of the Designer (Originator). As Check Print corrections are made to the Drawing Original, the person making the changes circles in **green** each correction as incorporated. When all corrections are complete, the person correcting the drawing signs and dates the Check Print stamp.

5. Verifying the Corrected Check Print

The Verifier (usually the Checker) verifies the corrected drawing against the Check Print to assure that the agreed-to corrections have been incorporated without error.

If the corrections are not made or are made incorrectly, the Check Print with penciled instructions is returned to the corrector. The Verifier marks in **yellow** each green-circled item after reviewing its incorporation on the Original Drawing. At the conclusion of the checking process, everything on the drawing should be marked in yellow.

The Verifier signs and dates the Check Print stamp, as applicable.

After the corrections have been verified, the Checker initials the "Checked by" block on the title block of the Drawing Original.

At the completion of the QC Review, all check boxes in the drawing title block should be initialed. The "Design and Detailing Progress" form will also be completely filled out (hand initialed) at this time.

To complete the checking process, the Designer of Record fills out the project information on the Design Certification for Design Plans form (Form SQ-2) and seals and signs the Design Certification section. The Checker seals and signs the Design QC Certification section.

6. Disposition of the Checked Drawing

The completed original (or CADD file) is placed under the control of the Senior Design Engineer to prevent further changes to the drawing that could invalidate the checking which has been done.

The Senior Design Engineer releases the checked drawing to the Region or to other design sections as necessary.

7. Additional Changes or Corrections

When a change is made to a checked drawing, a new Check Print must be made to check the area that has been changed. The Check Print is stamped and labeled Check Print 2, 3, 4, etc., as applicable and attached to the previous check print(s). The checking follows the same procedure as that of the original Check Print, except that only the portions that changed are marked up as having been checked.

2.5.8 PREPARING SPECIFICATIONS AND THE ENGINEER'S ESTIMATE

Design Activity: 01P, 05P, 07P, 10P

Specifications

Specifications define work items that are not and/or cannot be defined completely in the plans. For the purpose of this document, the term *specification* may refer to a *standard specification* or a *special provision*.

All UDOT projects will use the current UDOT Standard Specifications for Road and Bridge Construction. At times, it becomes necessary to modify or correct the standard specifications or to create new specifications. Project specific changes to standard specifications are made by creating a special provision. When a special provision is used consistently on all projects, it should be submitted to the UDOT Standards Committee for adoption as a standard specification.

The construction requirements defined in the specifications must fulfill all design assumptions, and provide durability and structural adequacy for all structural elements. Specification requirements are based upon the technical requirements for strength, durability, workmanship and constructability. In some instances, UDOT specifications may be more stringent than industry standards to provide added durability due to the unique aspects of Utah's environment.

The primary resource to be used when creating and modifying specifications is either the *AASHTO Standard Specifications for Highway Bridges, Division II* or the *AASHTO LRFD Standard Specifications for Bridge Construction* depending upon which design specification is used. These specifications have been adopted by transportation agencies across the country and as such represent the industry standard for the construction of highway structures. Any deviations from these two construction specifications should be based upon the Department's experience and thorough investigation of the technical requirements of the structural element.

A qualified engineer/designer composes and drafts the specification under the direction of the Senior Design Engineer. The Originator verifies that the new specification or special provision will not duplicate or inadvertently supersede other specifications.

Create the new specification document in MS Word format and in a format compatible with the Department's electronic bid system. Templates and instructions are available on UDOT's web-site. Use the UDOT standard format, MS Word template and other requirements for specification preparation. Complete all specifications and special provisions prior to the PS&E review to allow other design and construction disciplines to review the changes or additions prior to release for construction.

The Deputy Bridge Engineer for Design reviews and approves all new special provisions prior to implementation as part of the final design review and approval.

Engineer's Estimate

Prepare the Structures section of the Engineer's Estimate using the Department's *Project Development Business System (PDBS)*. PDBS is a computer program that was specifically created for generating

project bid estimates.

Ensure that the Engineer's Estimate is complete and accurate by doing the following:

1. List each bid item and quantity exactly as shown in the plans.
2. Match the bid item numbers and names with the applicable specifications and plan quantities.
3. When a specification defines a new bid item, add it to the project estimate in PDBS and to the Measurement and Payment specification.
4. Provide the quantity and unit price for each item.
5. Verify that the unit costs are reasonable for the bridge type and location.

Measurement and Payment Specification

Check the Measurement and Payment document for correctness and completeness of structure items. Add additional items and information as necessary.

2.5.9 CHECKING SPECIFICATIONS AND THE ENGINEER'S ESTIMATE

Design Activity: 01P, 05P, 07P, 10P

Design documents are checked and reviewed to assure that the engineering for the project is sound. Measures for the selection and review of materials, equipment, and elements of the Work included in the Project are handled with specifications which are developed during the design process. This procedure ensures that work is adequately specified.

Responsibilities

The **Senior Design Engineer** is responsible for implementing this procedure on his/her project on an on-going routine basis.

The **Originator** of the work on a document has the primary responsibility for accuracy and adequacy. It is not intended that the Originator rely upon the checking system to find and correct his/her mistakes.

The Originator of each document is responsible for making the Check Print, following the Check Print through the checking process, and obtaining the required sign-offs.

The **Checker** is responsible for checking the documents, independent of the Originator.

Procedure for Checking Specifications and Engineer's Estimate

The Originator provides to the Checker a complete copy of the new specification, the engineer's estimate, and the structures section of the Measurement and Payment specification with a Check Print stamp on the reverse side of the first page of each document.

The Checker reviews the new specification, the Engineer's Estimate, and the Measurement and Payment specification for applicability, clarity, and completeness. The Checker checks that bid item names and numbers are consistent between the plans, the specifications, the engineer's estimate and the Measurement and Payment specification. The Checker verifies that the unit costs shown in the estimate are reasonable for the structure design and location.

The Checker completes a RYG check of all documents supplied by the Originator. Each page is marked through in **yellow**, indicating that it was reviewed. Corrections are annotated in **red** and the sheet is tabbed for easy location. Upon completion of the checking, the Checker signs and dates the Check Print stamp.

The Originator back checks the corrections for concurrence, has them incorporated into the applicable document, signs and dates the Check Print stamp, and provides a corrected copy to the Checker.

The Checker verifies that the corrections have been made in the original documents and signs as the Verifier on the Check Print stamps.

2.5.10 COMPUTER SOFTWARE VERIFICATION

Design Activity: N/A

The requirements for verification of computer software apply to all purchased, contracted, or locally prepared software that will be used for design or calculations. Do not use unverified computer software for any final design until these procedures have been followed. Software verification is required prior to the first time usage of all computer programs, spreadsheets, etc. New releases of previously verified software and modified spreadsheets are considered to be new software and must be verified according to these procedures.

The **Deputy Bridge Engineer for Design** identifies and approves the design software to be used for design and assesses the availability of verification documentation for that software. When verification documentation for a particular application does not exist, appropriate assignments are made to fulfill the requirements of this procedure.

The **Designer** is responsible for the complete design of the structure. The use of validated computer software does not relieve the designer from the responsibility for the proper application and interpretation of the software and its results. The Designer should take whatever steps deemed necessary to feel confident in using any computer design software. Consider the following as minimum requirements.

Procedure

1. When it is determined that a first time usage of software or a new application is required for engineering calculations, the software/software application is validated and documented using one of the following methods:
 - a. Hand Calculations.
 - i. Hand calculations with the same formulation or a parallel technique are documented and checked in accordance with the procedures for preparing and checking design calculations in this plan.
 - ii. The same input and assumptions used in the hand calculations are formatted and input into the computer to check the software. The computer input is checked in accordance with the procedures for checking input to computer programs in this plan.
 - iii. The computer output is compared to the results of the hand calculations with each corresponding answer annotated as equivalent values. Differences which are not obviously accountable to rounding are explained on the output sheet.
 - b. Calculations Using Previously Verified Software
 - i. Input and output from a previously verified software program may be substituted for the original hand calculations.
 - ii. The computer input from the previously verified software and the computer input

from the non-validated software are checked in accordance with the procedures for checking input to computer programs in this plan.

- iii. The computer output is compared to the results from the previously validated software with each corresponding answer annotated as equivalent values. Differences which are not obviously accountable to rounding are explained on the output sheet.
 - c. Complete documentation of the verification includes the software name, version, release date, fully checked calculations, checked computer input, printout of program when available, annotated output printout, a brief description of the processes followed and the completed Certification for Design Computer Software Verification.
2. The validation of some software may require multiple design problems. Software must be validated for each different type of design problem for which it is used. For instance, software that can be used for the design of straight and curved steel girder bridges and has been validated for the design of straight steel girders cannot be used for the design of curved steel girders until it is validated for curved girders.
 3. Updates to verified software may require re-verification.
 - a. Prior to using any software updates, submit to the Deputy Bridge Engineer for Design a request to use the software update. The Deputy Bridge Engineer for Design will evaluate the update to determine whether verification of the software update is required. Updates to validated software require re-verification if the software involved a change to any mathematical formulas. If the software changes are strictly cosmetic in nature, then re-verification is not required.
 - b. Re-validate updated computer programs by running the updated programs and comparing the output to that of the previously validated version of the program, following the procedures in Step (1) of this procedure.
 4. The Deputy Bridge Engineer for Design will maintain a list of verified computer software that is approved for use in the design of structures on UDOT projects.
 5. Consultants hired by UDOT who use computer software in the performance of their contracted planning and design work must meet the same requirements for software verification as UDOT design engineers.

2.5.11 QUALITY ASSURANCE (QA) AUDIT

A Quality Assurance (QA) Audit is required for all design documents (plans, specifications, engineer's estimate, calculations, reports, etc.). The QA Audit verifies that the QC check is complete and that it followed the established QC procedures. Therefore, the QA Audit must occur after the QC Check is complete. The QC Check and the QA Audit are completed prior to the PS&E submittal.

The Senior Design Engineer or another experienced senior level engineer is responsible for the QA Audit. The complete QA Audit includes the checking of all design documents (plans, specifications and engineer's estimate, calculations, reports, etc.).

QA Audit Procedure

Design Activity: 49D, 01P, 05P, 07P, 10P

When the QC Check is complete, the Designer provides the complete QC documentation to the QA Auditor. The QA Auditor verifies that the QC documentation is complete and that the QC Check was completed according to the appropriate procedures. Check prints for all design documents including plans, specifications, engineer's estimate, calculations and reports are checked to see that all text and details are marked yellow and the documents are signed off in accordance with the appropriate procedures.

If deficiencies are found during the QC Check, the deficient check prints are returned to the Checker to complete the QC Check. Upon completion of the QC Check, the QA Engineer verifies that all deficiencies have been corrected and completes the QA Audit.

The QA Auditor certifies that the QC and QA Checks are complete by signing and sealing the Design QA Certification section of the appropriate Design Certification Form.

2.5.12 QUALITY ASSURANCE (QA) REVIEW

A QA Review occurs at two points in the design process: (1) near the end of Preliminary Design (Situation & Layout QA Review), and (2) near the end of Final Design (Final QA Review). A successful QA Review leads to design approval by the Deputy Bridge Engineer for Design.

Situation and Layout Review and Approval

Design Activity: 56D

After the Situation and Layout plans are complete and prior to beginning final design, the Senior Design Engineer submits to the Deputy Bridge Engineer for Design the items listed on Form SA-2, "Situation & Layout Design Approval." Do not begin the final design of the structure prior to receiving S&L Design Approval.

The Deputy Bridge Engineer for Design will review and approve the Situation and Layout design.

Final QA Review

Design Activity: 33P

After the PS&E Review is complete and the design documents have been updated and finalized, the Senior Design Engineer submits to the Deputy Bridge Engineer for Design the items listed on Form SC-4, the "Final Design QA Review Checklist" for the Final QA Review. The Deputy Bridge Engineer for Design or his designee completes the review for UDOT in-house designs. For projects designed by Consultants, the Final QA Review is completed by an appropriate senior level structural engineer on the Consultant's staff.

The intent of the Final QA Review is to verify that the final design documents are complete and the contract documents are ready for advertising. This is not a detailed check, but a review to ensure confirm that the design is complete and the appropriate processes were followed. The final design documents are reviewed for the following:

1. **Completeness.** Review the final design documents for completeness.
 - a. All submittal items are included. Design documentation is complete.
 - b. Contract Documents (plans, specifications, estimate) are complete. Plans and calculations are signed and sealed.
 - c. Verify that the plans include all details and information necessary to build the structure. This review is not to make a detailed check of all this information, but to verify that it is present.
 - d. Verify that all necessary special provisions are included.
 - e. All necessary forms and checklists are included.
2. **General.** Confirm the following:
 - a. The design meets the design intent.
 - b. The computer software used for design is acceptable.

- c. The designated seismic strategy is appropriate and is correctly implemented in the structure design. The Seismic Strategy Report matches the designed strategy.
 - d. Standard details are up-to-date and incorporated appropriately.
 - e. The design complies with project aesthetic and environmental requirements.
 - f. All previous comments are incorporated.
 - g. Identify any significant design flaws in the design documents.
3. The contract documents are **Biddable**:
4. **Plans.** Verify that all required construction bid items are listed in the Quantities table of the Situation and Layout sheet(s). Verify agreement between items in the plans, specifications and estimate.
 - a. **Specifications.** Verify that the specifications cover all necessary work items. Construction items not covered by the standard and supplemental specifications require a special provision. Review special provisions for accuracy and completeness.
 - b. **Engineer's Estimate.** Verify that the quantities in the engineer's estimate agree with the quantities shown on the plans and that the titles match exactly the bid items in the Measurement and Payment specification. Verify new bid items specific to this project comply with Department standards for new bid items. Verify that estimated costs are reasonable for the structure design and location. Calculate the cost per unit area for the bridge excluding approach slabs. Compare the cost with recently advertised bridges of similar type.
5. **Constructability.** Review the plans for problems that would impact construction. Identify details that would require the Contractor to do the impossible or near impossible. Identify details or construction sequencing that can be modified to improve constructability without impacting the quality or design life of the completed structure.
6. **Inspectability.** Verify that all major components of the completed structure are accessible for inspection and maintenance. Verify that the provided access meets safety requirements.
7. **Maintainability.** Check the major elements of the bridge for built-in problems that would impact bridge maintenance. For instance, verify that the deck drains will not drain onto the girders or substructure. Identify erosion or snow removal problems that can be avoided.
8. **Security.** Verify that public access to sensitive areas is prevented.
9. **Documentation.** Complete and sign Form SC-3 "Final Design QA Review Checklist" certifying that the Final Design QA Review is complete and that the contract documents are recommended for approval.

2.6 CONSTRUCTION SUBMITTALS

The Structures Division assists the Construction Division by reviewing and responding to various types of structure-related construction submittals. Construction submittals generally consist of documents which are used to supplement the Design Documents as necessary to control the work. Typically, the types of construction submittals received include Field Change Requests and Non-Conforming Items that require input from the structural designer, Fabricator's Shop Drawings, Erection Drawings, and Contractor's Working Drawings for such items as temporary structural supports, shoring, falsework, non-typical formwork, etc. In accordance with contract requirements, the Contractor / Fabricator provides five sets of all submittal documents (drawings are 11" x 17" size). Erection Drawings and Contractor's Working Drawings are usually only submitted when specifically required by the contract specifications.

2.6.1 Responsibilities and Procedure

The **Deputy Bridge Engineer for Design** receives all Construction Submittals from the UDOT Resident Engineer. Fabricator's Shop Drawings may come directly from the Fabricator. The Deputy Bridge Engineer for Design distributes the submittal to the Senior Design Engineer who has project responsibility for the submittal. This may be a design consultant.

The **Senior Design Engineer** assigns the construction submittal to personnel of appropriate expertise and familiarity to review Construction Submittals. This will typically be the Designer.

The **Reviewer** is responsible for reviewing construction submittals as assigned within the time allotted by the contract (usually 14 calendar days). Every effort should be made to complete Construction Submittal reviews in a thorough but timely manner.

The Reviewer logs the submittal into the Construction Submittal Log. He reviews the submittal for compliance with project drawings and specifications and notes any discrepancies. When reviewing fabricator's shop drawings, erection drawings and contractor's working drawings, comments and discrepancies are marked in red on the drawing itself. Check structural steel shop detail drawings in accordance with AASHTO / NSBA G 1.1-2000 "Shop Detail Drawing Review / Approval Guidelines." This document provides a suggested list of check items. The document may be downloaded from the Internet at <http://www.steelbridge.org/standards.htm>.

When the review is complete, the reviewer stamps and signs or initials each drawing with the appropriate shop drawing stamp, either "Approved As Noted" or "Not Approved." Additional sets are marked identically as the original.

The Reviewer completes the submittal entry in the Construction Submittal Log with the completion date and returns the submittal to the Senior Design Engineer who reviews it for satisfactory completion. The Senior Design Engineer or the Reviewer prepares the transmittal letter. A template for the shop drawing transmittal letter is available in the Hummingbird Document Management system. The Engineer in Responsible Charge signs the transmittal letter. The completed and signed transmittal letter is entered into the Hummingbird Document Management system and the submittal sets are distributed as follows:

1. UDOT Structures Division retains or receives one set.
2. Fabricator (one original set with original transmittal letter)
3. General Contractor (one set)

4. UDOT Project Engineer (one set)
5. UDOT Materials Division (one full-size set)
6. UDOT Project Manager (letter only)
7. UDOT Construction Division (letter only)
8. When consultant engineers review and approved construction submittals, they distribute one set to the UDOT Structures Division and retain one copy for their use and reference. This may require an additional set.

APPENDIX

Structures Design Process Flowchart

QC Color Code

Check Print Stamp

QC / QA Checklists

Form SC-1: 60% Design Review Checklist

Form SC-2: CADD Standards Check Checklist

Form SC-3: Design Calculations Checklist

Form SC-4: Final Design QA Review Checklist

Design Certification Forms

Form SQ-1: Design Certification for Design Calculations

Form SQ-2: Design Certification For Design Plans

Form SQ-3: Design Certification for Design Computer Software Verification

Design Approval Forms

Form SA-1: Alternate Design Quality Plan Approval

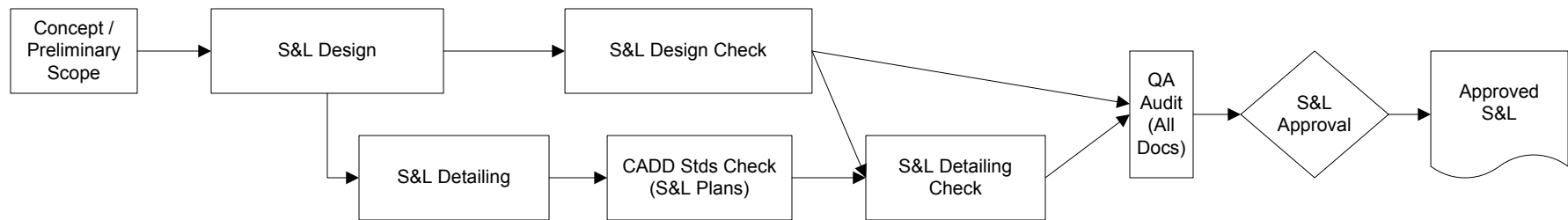
Form SA-2: Situation & Layout Design Approval

Form SA-3: Final Design Approval

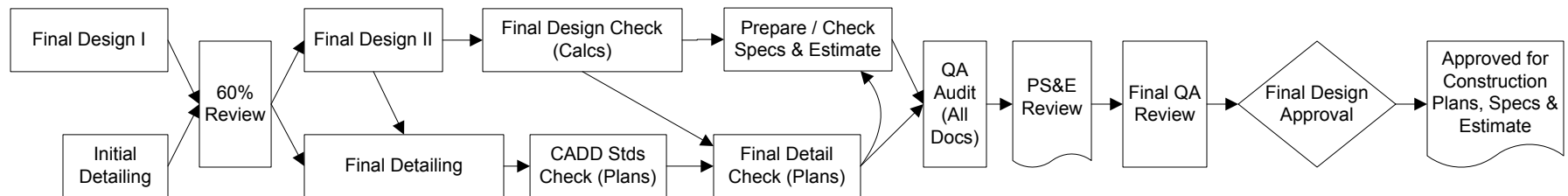
Structures Review Comment Form

STRUCTURE DESIGN QUALITY PROCESS

PRELIMINARY DESIGN



FINAL DESIGN



QC COLOR CODE

REMEMBER TO USE SIGN-OFF STAMP!

ORIGINATOR (DESIGNER)

Typed Text, Blueline Prints, Calculations, Black/White Copy

NOT IN: RED, YELLOW, OR GREEN

CHECKER (OTHER THAN DESIGNER)

Yellow for Correct

Red for "Corrections"

"Additions or Deletions"

changes

Use blue for notes to Originator

BACKCHECKER (DESIGNER)

Green Check Mark for Agreement

"Corrections"

Green Stet and Crossout when it is agreed "No Changes"

"Additions or Deletions"

ok

changes

UPDATER (ORIGINATOR/ DRAFTER)

Green Encirclement when Updated

"Corrections"

RECHECKER (OTHER THAN DESIGNER)

Yellow over Red and Green to indicate updated correctly



"Additions or Deletions"

ok

changes

REVIEWERS (NOT INVOLVED IN ACTIVITIES LISTED ABOVE)

Insures QC process was followed.

Comments in Blue identified by initials and dates.

FIGURE 2A-1: CHECK PRINT STAMP

No. _____Date _____

CHECKPRINT

Dwg. Checked against calcs. and
calc. check confirmed.

By _____Date _____

Checked _____Date _____

Backchecked _____Date _____

Corrected _____Date _____

Verified _____Date _____

UDOT STRUCTURES 60% DESIGN REVIEW CHECKLIST

Project Number: _____ Project Name: _____

PIN: _____ Structure Number: _____ Structure Type: _____

Structure Description: _____

ATTACHED ITEMS

The following items are completed and attached:

- | | |
|--|---|
| <input type="checkbox"/> 60% Structure Plan Set
<input type="checkbox"/> Calculations (if requested)
<input type="checkbox"/> Design Criteria Summary
<input type="checkbox"/> Approved Design Exceptions
<input type="checkbox"/> Computer Design Software List | <input type="checkbox"/> Seismic Strategy Report
<input type="checkbox"/> Geotechnical Report
<input type="checkbox"/> Previous Review Comments With Responses & Dispositions |
|--|---|

AT A MINIMUM CHECK THE FOLLOWING:

General:

- ☐ Meets Design Intent / Scope
- ☐ Design approach / software acceptable
- ☐ Seismic Strategy is appropriate and implemented in design
- ☐ Standard Details are used appropriately
- ☐ Aesthetic requirements are incorporated
- ☐ No significant design issues noted
- ☐ Significant design issues noted (See comment form)
- ☐ Special design procedures required (See comment form)

Constructability:

- ☐ Design accommodates constructability
- ☐ Horizontal and Vertical clearances accommodate constructability
- ☐ Construction sequencing is adequately addressed
- ☐ Shoring / Temporary Supports are adequately addressed
- ☐ Assess need for Contractor to submit Erection Plan

Maintainability:

- ☐ Maintenance-friendly details used
- ☐ Appropriate materials used

Inspectability:

- ☐ Inspection access is provided to all necessary components (bearings, expansion joints, closed sections, abutment backwalls, etc.)
- ☐ Inspection access meets safety requirements

Security:

- ☐ Public access to sensitive areas is prevented

REVIEWER

Signature: _____ Date: _____

Note: Record any comments on the UDOT Structures Review Comment Form.

UDOT STRUCTURES CADD STANDARDS CHECKLIST

Project Number: _____ Project Name: _____

PIN: _____ Structure Number: _____ Structure Type: _____

Structure Description: _____

Plan Sheet Number: _____ Plan Sheet Name: _____

Filename: _____ Directory: _____

AT A MINIMUM, CHECK THE FOLLOWING:

Drawing Organization:

- ☐ All CADD contract drawings are produced in MicroStation format according to UDOT CADD Standards (see *UDOT Engineering Technology Systems Manual*)
- ☐ File directory structure matches CADD Standards requirements (see *UDOT Engineering Technology Systems Manual*)
- ☐ File names comply with CADD Standards requirements. File names reflect the nature of their contents.
- ☐ Reference files (stored as read only) are used instead of copying existing data into file (as appropriate)
- ☐ Drawings / Details are referenced properly
- ☐ Correct seed files or libraries of standard features / details (stored as read only) are used.
- ☐ Any changes to seed files are approved by the Senior Design Engineer
- ☐ All unnecessary (temporary) files are deleted from all directories

Drawing Content:

- ☐ Drawing is flattened (Drawn 2D)
- ☐ All details are drawn to scale
- ☐ Correct lines styles are used and are on the correct levels
- ☐ Text is correct size and type
- ☐ All CADD-produced prints automatically produce the date, time and filename printed
- ☐ Drawing complies with UDOT Structures Division Drafting Standards
- ☐ All dimensions are auto-dimensioned & auto-annotation is used as appropriate
- ☐ Use of tags and file referencing is used appropriately

REVIEWER

Signature: _____ Date: _____

Note: Record any comments on the UDOT Structures Review Comment Form.

**UDOT STRUCTURES
DESIGN CALCULATIONS CHECKLIST**

Project Number: _____ Project Name: _____

PIN: _____ Structure Number: _____ Structure Type: _____

Structure Description: _____

INCLUDE THE FOLLOWING:

Organization:

- ☐ Title page with Structure Drawing Number, Structure Name, Design Calculations title, Designer's name.
- ☐ Table of Contents
- ☐ Uses standard Structures Division letter-sized calculation sheets for handwritten calculations and sketches
- ☐ Uses standard letter-sized paper with standard Structures heading for computer generated calculations
- ☐ All pages numbered with numbering scheme that covers entire set of calculations
- ☐ Identifies appropriate code references in right hand column
- ☐ Computer documentation includes: name of program, vendor, version number and release date
- ☐ Calculations cross-reference computer output as appropriate
- ☐ Stored in three-ring binder
- ☐ Check calculations stored in separate three-ring binder

Content:

- ☐ Complete Final Calculations
- ☐ All Design Certifications (place at beginning of calculations)
- ☐ All Design Approvals
- ☐ Design Criteria Summary
- ☐ Design Criteria Exceptions
- ☐ List of Computer Programs and Spreadsheets
- ☐ Bridge Type Selection Report
- ☐ Seismic Strategy Report (includes calculations)
- ☐ Load Rating Report
- ☐ Alternate Design Quality Plan Approval (if applicable)
- ☐ Completed Design Checklists
- ☐ Review Comments with Responses and Dispositions

REVIEWER

Name: _____ Date: _____

Note: Record any comments on the UDOT Structures Review Comment Form.

UDOT STRUCTURES FINAL DESIGN QA REVIEW CHECKLIST

Project Number: _____ Project Name: _____

PIN: _____ Structure Number: _____ Structure Type: _____

Structure Description: _____

ATTACHED ITEMS:

The following items are completed and attached:

- | | |
|---|---|
| <input type="checkbox"/> 100% Structure Plan Set | <input type="checkbox"/> Design Criteria Summary |
| <input type="checkbox"/> Special Provisions | <input type="checkbox"/> Approved Design Exceptions |
| <input type="checkbox"/> Engineer's Estimate | <input type="checkbox"/> Computer Design Software List |
| <input type="checkbox"/> Electronic Design Files (MicroStation) | <input type="checkbox"/> Final Seismic Strategy Report |
| <input type="checkbox"/> Completed Design Certification Forms | <input type="checkbox"/> Bridge Load Rating Report |
| <input type="checkbox"/> Final Bridge Design Calculations | <input type="checkbox"/> Geotechnical Report |
| <input type="checkbox"/> Independent Review Documentation (when required) | <input type="checkbox"/> Previous Review Comments With Responses & Dispositions |
| <input type="checkbox"/> 60% Design Review Checklist | |

AT A MINIMUM CHECK THE FOLLOWING:

Completeness:

- ☐ Plans are complete, sealed and signed by Utah PE
- ☐ Special Provisions included for all work / bid items
- ☐ Engineer's Estimate complete
- ☐ Bid costs are reasonable
- ☐ Calculations are complete and organized
- ☐ Previous comments addressed
- ☐ Design Approvals
- ☐ Load Rating complete and summarized properly
- ☐ Design Checklists complete & included with Calculations

General:

- ☐ Design Meets Design Intent
- ☐ Seismic Strategy implemented appropriately
- ☐ Design software acceptable
- ☐ Detailing matches standards
- ☐ Standard Details are used appropriately
- ☐ Plan Quantities match Engineer's Estimate
- ☐ Complies with Aesthetic requirements
- ☐ Significant design issues noted (Use comment form)

Constructability:

- ☐ Design accommodates constructability
- ☐ Horizontal and Vertical clearances accommodate constructability
- ☐ Constructible details are used
- ☐ Construction sequencing is adequately addressed
- ☐ Shoring / Temporary Supports are adequately addressed
- ☐ Assess need for Contractor to submit Erection Plan

Maintainability:

- ☐ Appropriate materials used
- ☐ Maintenance-friendly details used
- ☐ Maintenance access provided as necessary

Inspectability:

- ☐ Inspection access is provided to all necessary components (bearings, expansion joints, closed sections, abutment backwalls, etc.)
- ☐ Inspection access meets safety requirements

Security:

- ☐ Public access to sensitive areas is prevented

REVIEWER

The specified bridge design documents are complete and recommended for approval.

Signature: _____ Date: _____

Note: Record any comments on the UDOT Structures Review Comment Form.

UDOT STRUCTURE DESIGN CERTIFICATION FOR DESIGN CALCULATIONS

Project Number: _____ Project Name: _____

PIN: _____ Structure Number: _____ Structure Type: _____

Structure Description: _____

Type: ☐ Design Calculations ☐ Design / Field Change

Certification For: ☐ Complete Design ☐ Partial Design. Specify: _____

Structures Quality Plan: ☐ UDOT Structures QP ☐ Modified UDOT Structures QP
☐ Approved Alternate

DESIGN CERTIFICATION (Designer of Record)

By stamping and signing this section, I certify that the design documents specified comply with the requirements of the Project Design Criteria, including applicable AASHTO design specifications, and the Structures Design Quality Plan specified.

Print Name: _____ Date: _____

Design Firm: _____

PE Stamp (signed & dated)

DESIGN QC CERTIFICATION

By stamping and signing this section, I certify that the design calculations have been checked in accordance with the requirements of the Structures Design Quality Plan specified.

Print Name: _____ Date: _____

Design Firm: _____

PE Stamp (signed & dated)

DESIGN QA CERTIFICATION

By stamping and signing this section, I certify that I have verified that the QC for the design calculations specified above has been completed in accordance with the requirements of the Structures Design Quality Plan specified.

Print Name: _____ Date: _____

Design Firm: _____

PE Stamp (signed & dated)

Notes: 1. Design Certification is required for permanent structures of all types, including Bridge, Box Culvert, Multi-Plate Arch, Retaining Walls, Overhead Sign Structures, and Traffic, Signal, and Camera poles.
2. Attach signed approval form (SA-1) for any approved modifications to the UDOT Structures Design Quality Plan.
3. Maintain all QC/QA records for a minimum of 3 years after project completion.

UDOT STRUCTURE DESIGN CERTIFICATION FOR DESIGN PLANS

Project Number: _____ Project Name: _____

PIN: _____ Structure Number: _____ Structure Type: _____

Structure Description: _____

Submittal Type: ☐ S&L ☐ Final Design ☐ Design / Field Change ☐ As-Built

Certification For: ☐ Complete Design ☐ Partial Design. Specify: _____

Structures Quality Plan: ☐ UDOT Structures QP ☐ Modified UDOT Structures QP
☐ Approved Alternate

DESIGN CERTIFICATION (Designer of Record)

By stamping and signing this section, I certify that the design plans specified above comply with the requirements of the UDOT Structures Design & Detailing Criteria.

Print Name: _____ Date: _____

Design Firm: _____

PE Stamp (signed & dated)

DESIGN QC CERTIFICATION

By stamping and signing this section, I certify that the design documents specified have been checked in accordance with the requirements of the Structures Design Quality Plan specified.

Print Name: _____ Date: _____

Design Firm: _____

PE Stamp (signed & dated)

DESIGN QA CERTIFICATION

By stamping and signing this section, I certify that I have verified that the QC for the design documents specified above has been completed in accordance with the requirements of the Structures Design Quality Plan specified.

Print Name: _____ Date: _____

Design Firm: _____

PE Stamp (signed & dated)

CADD STANDARDS CERTIFICATION

By signing this section, I certify that the structure plans specified above comply with the UDOT Structures CADD Standards.

Signature: _____ Design Firm: _____ Date: _____

Notes: (1) Design Certification is required for permanent structures of all types, including Bridge, Box Culvert, Multi-Plate Arch, Retaining Walls, Overhead Sign Structures, and Traffic, Signal, and Camera poles. (2) Attach signed approval form (SA-1) for any approved modifications to the UDOT Structures Design Quality Plan. (3) Maintain all QC/QA records for a minimum of 3 years after project completion.

UDOT STRUCTURE DESIGN CERTIFICATION FOR DESIGN COMPUTER SOFTWARE VERIFICATION

Type: ☐ Commercial Software ☐ Spreadsheet ☐ Other: _____

Software Vendor / Originator: _____

Program Name: _____ Version: _____

Program Description: _____

Verification Method: ☐ Hand Calculations
☐ Previously Verified Software. Specify: _____

Structures Quality Plan: ☐ UDOT Structures QP ☐ Modified UDOT Structures QP
☐ Approved Alternate (Attach signed approval)

DESIGN CERTIFICATION (Designer of Record)

By stamping and signing this section, I certify that the computer software specified above has been verified in compliance with the Structures Quality Plan specified, and meets the requirements of the UDOT Structures Design Criteria, including applicable AASHTO design specifications.

Print Name: _____ Date: _____

Design Firm: _____

PE Stamp (signed & dated)

DESIGN QC CERTIFICATION

By stamping and signing this section, I certify that the software verification design calculations have been checked in accordance with the requirements of the Structures Design Quality Plan specified.

Print Name: _____ Date: _____

Design Firm: _____

PE Stamp (signed & dated)

DESIGN QA CERTIFICATION

By stamping and signing this section, I certify that I have verified that the QC for the software verification specified above has been completed in accordance with the requirements of the Structures Design Quality Plan specified.

Print Name: _____ Date: _____

Design Firm: _____

PE Stamp (signed & dated)

Notes: *This submittal is required for all design software not on the UDOT Structures Division list of approved software before UDOT Structure will approve any bridge design that uses the software. Submit to UDOT Structures Division the following: (1) this completed certification form, and (2) the complete software verification documentation including calculations and QC/QA records.*

**UDOT STRUCTURES
ALTERNATE DESIGN QUALITY PLAN APPROVAL**

Project PIN: _____ Project Number: _____

Project Name: _____

Type: ☐ Modifications to UDOT Structures Quality Plan
☐ Alternate Project Quality Plan

Request For: ☐ All Structures on project
☐ Specified Structures Only

List UDOT Structure Numbers: _____

Reason for Change: _____

REQUEST

The attached changes to the UDOT Structures Design Quality Plan are requested for use on the specified project. I certify that the use of the submitted plan will maintain the intent of the UDOT Structures Quality Plan.

Print Name: _____ Design Firm: _____

Signature: _____ Date: _____

APPROVAL

I approve the submitted Alternate Structure Design Quality Plan for use on the specified project.

Signature: _____ Date: _____
(UDOT Deputy Bridge Engineer for Design)

UDOT PROJECT MANAGER CONCURRENCE

I concur with the recommended changes to the Structure Design Quality Plan and its use on the specified project.

Signature: _____ Date: _____

Note: The UDOT Structures Design Quality Plan governs the design quality for permanent structures of all types, including Bridges, Box Culverts, Multi-Plate Arch Structures, Retaining Walls, Overhead Sign Structures, and Traffic, Signal, and Camera poles. Design processes not covered by the submitted plan must comply with the UDOT Structures Quality Plan. Submit the requested plan changes with this form for approval.

UDOT STRUCTURES
SITUATION & LAYOUT DESIGN APPROVAL

Project Number: _____ Project Name: _____

PIN: _____ UDOT Structure No.: _____ Structure Type: _____

Structure Description: _____

ATTACHED ITEMS

The following items are completed and attached:

- ☐ Situation & Layout plan sheet(s)
- ☐ Design Plan Design Quality Certification (completed for S&L plan sheets)
- ☐ Bridge Type Selection Report
- ☐ Preliminary Seismic Strategy Report
- ☐ List of Computer Software to be used in Final Design
- ☐ Design Criteria
- ☐ Design Exceptions Approval Form (if applicable)

LEAD STRUCTURAL DESIGNER

I certify that the attached Situation & Layout plans for the specified structure are complete, meet all applicable design requirements, and are ready for approval.

Signature: _____ Date: _____

Design Firm: _____

APPROVAL

I approve the submitted Situation & Layout plans for the specified bridge.

Signature: _____ Date: _____
(UDOT Deputy Bridge Engineer for Design)

Note: Approval of Situation & Layout plans is required prior to beginning final design. Approval requires the submittal of all items listed in the Attached Items box.

UDOT STRUCTURES FINAL DESIGN APPROVAL

Project Number: _____ Project Name: _____

PIN: _____ Structure Number: _____ Structure Type: _____

Structure Description: _____

ATTACHED ITEMS

The following items are completed and attached:

- ☐ Completed Structure Plans (Signed & Sealed)
- ☐ Specifications (Special Provisions)
- ☐ Engineer's Estimate
- ☐ Final QA Review Checklist
- ☐ All Design Certification Forms (for Final Design)
- ☐ Design Criteria Summary
- ☐ Approved Design Exceptions
- ☐ Computer Design Software List
- ☐ Final Seismic Strategy Report
- ☐ Geotechnical Report
- ☐ Bridge Load Rating Report
- ☐ Structure Design Calculations*
- ☐ Independent Review Checklist, Letter Report and Calculations (when required)
- ☐ Previous Review Comments With Responses & Final Dispositions
- ☐ Any other final design documents and reports, as appropriate

LEAD STRUCTURAL DESIGNER

I certify that the attached Final Design Plans, Specifications and Estimate for the specified structure are complete, meet all applicable design requirements, and are ready for approval.

Signature: _____ Date: _____

Design Firm: _____

APPROVAL

The submitted Final Design Plans, Specifications and Estimate for the specified structure are Approved for Construction.

Signature: _____ Date: _____
(UDOT Deputy Bridge Engineer for Design)

Note: Approval of Final Design plans is required prior to advertising the project. Approval requires the submittal of all items listed in the Attached Items box. *Design calculations are required for all UDOT structure designs. Submit design calculations for local agency structures when requested.

UDOT STRUCTURES DIVISION COMMENT AND RESOLUTION SHEET

CODES:

- A. ACCEPT COMMENT—WILL BE CORRECTED, ADDED, OR CLARIFIED.
 B. DESIGNER WILL EVALUATE.
 C. DELETE COMMENT
 D. DEPARTMENT TO EVALUATE.

DOCUMENT CONTROL NUMBER:		REVIEW TYPE:		REVIEWER(S):	DATE:
DESCRIPTION:		DESIGNER:		DISCIPLINE: STRUCTURES	CRM:
ITEM NO.	DWG. NO. ⁽¹⁾	COMMENTS	CODE ⁽²⁾	RESPONSE ⁽²⁾	FINAL DISPOSITION ⁽³⁾
1					

- (1) Indicate drawing no./page no. or use "G" for general comment.
 (2) To be filled out by Designer.
 (3) To be determined in subsequent comment resolution meeting/discussion (list date).

Note: The intended use of this form is to provide a means for the Department to comment on submitted structural design plans and calculations. All comments must be satisfactorily resolved and incorporated into the contract documents before the design can be approved.